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BULLETIN 283 **DECEMBER, 1919**

ANIMAL HUSBANDRY INVESTIGATIONS IN 1919

CONTENTS

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BULLETIN 283

REPORT OF PROGRESS ON ANIMAL HUSBANDRY INVESTIGATIONS IN 1919.[1]

By John W. Gowen.

This brief abstract in conformity with previous reports,[2] deals with the progress which has been made during the past year in the animal husbandry investigations carried on by the Maine Agricultural Experiment Station. The work has been energetically pushed toward the publication of the results already obtained and to the solution of other problems of importance to us as dairymen. Six papers pertaining to this subject have been published or are in press.

a. Variations and Mode of Secretion of Milk Solids. By John W. Gowen.

b. The Variation of the Milk of Ayrshire Cows in Quantity and Fat Content of their Milk. By Raymond Pearl and John Rice Miner.

c. Studies in Milk Secretion. V. On the Variations and Correlations of Milk Secretion with Age. By John W. Gowen.

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[1]Papers from the Biological Laboratory of the Maine Agricultural Experiment Station No. 130.

This report of progress during the year 1919 of the work on animal breeding and related lines (exclusive of the work with poultry) carried on in the Biological Laboratory of the Maine Agricultural Experiment Station, was presented as the report of the Committee on Breeding of the Maine Dairymen's Association at the meeting held in Bangor November 19, 1919.

[2]Gowen, John W., Report of Progress on Animal Husbandry Investigations in 1917. In 1918 Maine Agricultural Experiment Station Annual Report, pp. 205-228, 1918.

Pearl, R., Report of Progress on Animal Husbandry Investigations in 1916, Maine Agricultural Experiment Station, Annual Report, pp. 121-144, 1916.

Pearl, R., Report on Animal Husbandry Investigations in 1915, Maine Agricultural Experiment Station Misc. Publ., 519, 1-27, 1915.

d. Studies in Milk Secretion. VI. On the Variations and Correlations of Butter-Fat Percentage with Age in Jersey Cattle. By John W. Gowen.

e. Studies in Milk Secretion. VII. Transmitting Qualities of Jersey Sires for Milk Yield, Butter-Fat Percentage and Butter. By Raymond Pearl, John W. Gowen and John Rice Miner.

f. Conformation and Its Relation to Milk Producing Capacity in Jersey Cattle. By John W. Gowen.

A brief review of some of the salient points of these papers will be given under the appropriate division. The progress that has been made in the solution of the other problems relating to this work is summarized under the heading into which it may fall.

ANALYSIS OF MILK RECORDS

The records for milk production contained in the Advanced Registries have been used in the investigations of the past year. It will be remembered that the mean yearly milk yields at successive ages have been determined for the Jersey and for the Guernsey breeds. The 365 day milk records of the Holstein-Friesian breed have furnished the material to determine the same information on this breed. A comparison of these results is of a good deal of interest as it furnishes one of the best criteria to determine whether the physiological effect of age on milk production is the same on these three breeds and presumably the same on all cattle. The necessity of establishing this point needs little amplification for it is clear that only when the point is established can the results determined for one breed of cattle be generalized and the generalization applied to the rest of the species.

The curves describing the relation of age at calving to the subsequent yearly milk yield are all logarithmic functions. The equations themselves are.

Holstein-Friesian Milk Yield $= 11351.5 + 873.67x - 32.225x^2 + 1548.4 \text{ Log. } x$

where x equals the age in units of six months commencing at one year and three months of age for the zero point.

Guernsey Milk Yield$=6681.5+104.42x-5.284x^2+2846.5 \log x$. where x equals the age in units of six months commencing at one year and three months of age for the zero point.

Jersey Milk Yield$=4586.5+307.55x-12.65x^2+2216.6 \log x$. where x equals the age in units of six months commencing at nine months of age for the zero point.

These equations furnish the information necessary to answer the above question; the only question which arises is how best to present the facts. Breeders have long recognized that the average milk production for the breeds differs considerably. It appears best, therefore, to get some means of expressing the relationship desired which shall eliminate this difference in the absolute yields. This may be done by determining for a given breed the curve for the amount by which the milk productions at the different ages, beginning at say 1 year and 9 months, should be multiplied to give the milk production at a constant age, say 8 years. Concretely considered if the mean milk production of the 2 year old group is 12862 pounds and the mean milk production of the 8 year old group is 19023 pounds the multiplication factor will be $\frac{19023}{12862}$ or 1.479; if the mean[3] year old milk production was 14857 the factor will be $\frac{19023}{14857}=1.281$. Generalized this means that if a, b, c, d .... equal the mean milk productions at 2, 3, 4, 5......... years of age and K equals the mean milk production at 8 years of age the curve for the breed may be found by $\frac{K}{a}, \frac{K}{b}, \frac{K}{c}, \frac{K}{d} --- \frac{K}{n}$ Such a curve for each breed gives the information desired for these curves will be entirely comparative and comparative on the same basis. Figure 26 page 252 shows this curve.

The three curves in Figure 26 show a striking similarity in shape. This similarity is even more striking where the large variability of milk production is taken into consideration. It is true that the Guernsey breed differs somewhat from the other breeds in reaching its maximum yield later in life and having a lower rate of decline in milk yield after maturity. This difference is, however, probably only slightly significant, based as it is on the rather small numbers of this end of the curve. The curves of Figure 26 show that age increases or decreases the milk yield of the high producing breeds more than the milk yield of the lower producing breeds. This increase or decrease

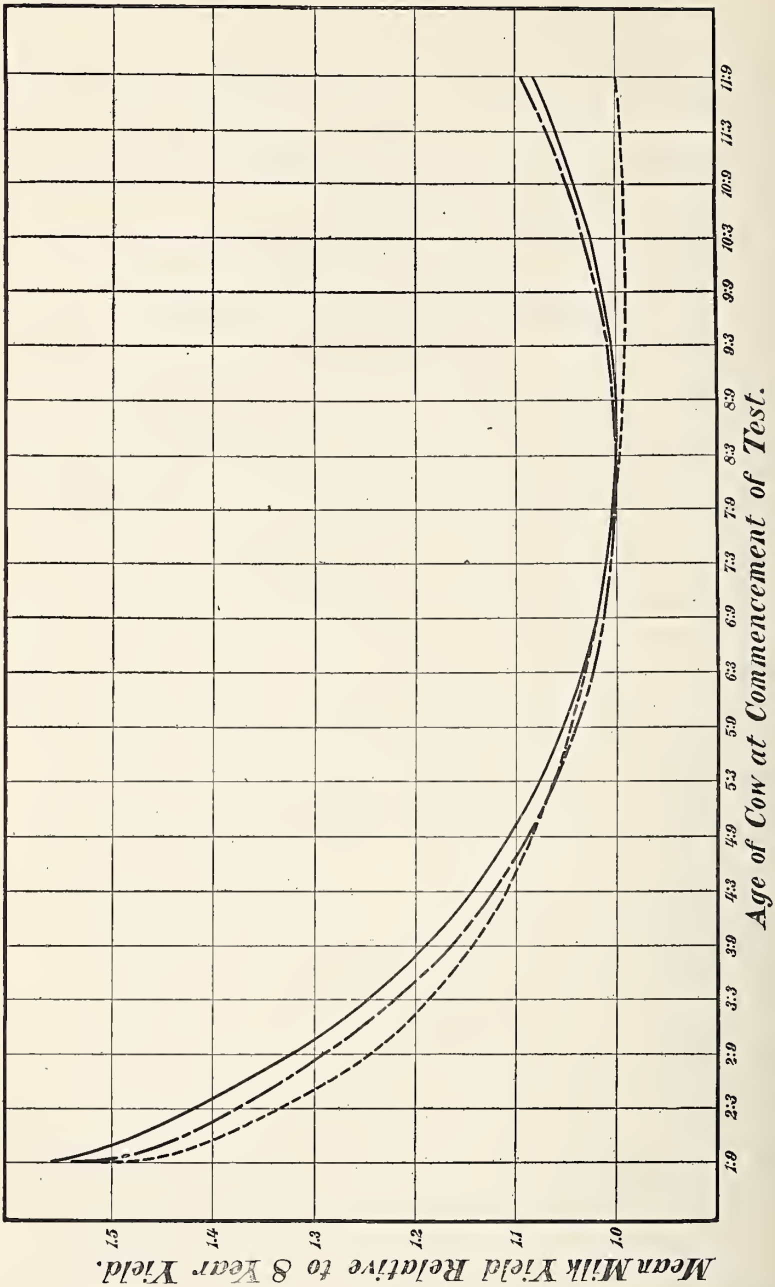

FIGURE 26. Curves showing the relation between the mean milk productions of 8 years and the mean milk yields of the other age for the Jersey, Holstein-Friesian and Guernsey breeds.

is, however, fairly closely proportional to the breed's milk yield at eight years. Such being the case it follows that the relative physiological effect of age on milk production of the different breeds is the same.

Should this be granted it follows that the results for milk yield determined for one breed will probably be correct for another breed insofar as this age effect is concerned.

AGE AT WHICH THE COWS OF THE DIFFERENT BREEDS REACH MATURITY OR MAXIMUM MILK PRODUCTION.

Some interest is attached to the age at which the different breeds reach their maximum productivity. This question may be answered insofar as it related to advanced registry data. From the equation to the curves given above it is possible by differentiation to determine the age at which maximum yield occurs. When this is so determined the results are:

Holstein-Friesian maximum milk yield occurs at 8 years, 4 months, 29 days.

Guernsey maximum milk yield occurs at 9 years, 8 months, 5 days.

Jersey maximum milk yield occurs at 8 years, 1 month, 13 days.

These ages at maximum milk yield show that the Jersey reaches this yield before any of the other breeds. Closely following this breed is the Holstein-Friesian with the maximum milk yield at 8 years, 4 months and 29 days. The Guernsey is the last breed to reach its maximum yield. This breed reaches this yield at 9 years, 8 months and 5 days. In consideration of these maximum yields it should be remembered that for some time prior to and after the age at which the maximum yields of milk occurs the cow is giving nearly this amount of milk. Further than this milk production in itself is highly variable. All these fluctuations taken into account the close agreement between these ages of maximum productivity for the breeds is rather surprising.

TRANSMITTING QUALITIES FOR MILK PRODUCTION, BUTTER-FAT PERCENTAGE AND BUTTER-FAT OF GUERNSEY SIRES TO THEIR SONS.

In the report of last year[3] three tables were given to enable the breeder to determine the worth of Guernsey sires for milk production, butter-fat percentage and butter-fat.*

The tables were made by determining the milk production, butter-fat percentage and butter-fat corrected for age. For the cow with more than one record the records were each corrected for age and averaged and this average used for that cow. In a similar paper on the Jersey sires[4] the record nearest 8 years was chosen for correction if the cow had two or more year records. The difference in arriving at the end results is obvious. Each method has its merits. The work of calculation for the Guernsey sires was completed before it was discovered that this difference in method existed in approaching the end results. For the sake of uniformity and to enable the results to be compared it was therefore determined to do the work for the Guernsey breed all over again employing the method used for the Jersey breed. This has been done. The records published for the Guernsey sires in last year's report use the average productions of the daughters with two or more records in determining a bull's worth. The records for the Guernseys in this report and as will be hereafter published use the record nearest 8 years of age for those daughters which have two or more records. Either method is correct and according to the preferences of the readers have their supporters.

It is possible to determine what the transmitting qualities of a sire to his sons may be by determining for those sons what their daughters did in the way of milk production, butter-fat

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[3]Gowen, John W., Report of Progress on Animal Husbandry Investigations in 1917. In 1918 Maine Agricultural Experiment Station Annual Report, pp. 205-228, 1918.

*These tables contained all Guernsey sires with 7 or more tested daughters from advanced registry dams. The tables and the text matter pertaining thereto were copied in their entirety by the Hoard Dairyman, 3.

[4]Studies in Milk Secretion. VII. Transmitting Qualities of Jersey Sires for Milk Yield, Butter-Fat percentage and Butter-Fat in 1919, Maine Agricutural Experiment Station Annual Report, pp. 89-204, 1919.

percentage and butter-fat in comparison with what the daughters' dams' yield was for these same variables. The information for the Guernsey sires has been arranged to bring out this point in table 1. The arrangement of this table is made on the basis of how much butter-fat the sire's son or sons caused his daughters to produce in excess or defect of their dams. The mean of each item is taken for each sire's son if he has more than one son of known transmitting powers. The information given in this table is as follows: (1) the number which the sire takes in the series of sires, in the butter-fat transmitting qualities of his sons is given in the first column; (2) the sire's name is given; (3) immediately under the sier's name is given the sons' names indented somewhat; (4) beside each bull's name is given his registry number, the number of daughter-dam pairs that he has, the net change in the milk production which his daughter produced in comparison with their dams, the net change in the butter-fat percentage and the net change in the butter-fat.

Out of a total of 181 sires with sons which are tested by their daughter-dam test only those are chosen which have at least two such tested sons. Table 1 shows this information for this selected list.

TABLE 1.

Table Showing Transmitting Qualities of Certain Guernsey Sires to Their Sons.

No.	Name of Sire and Sons	Registry No.	No. of Pairs	Net Change in Milk	Net Change in %	Net Change in Fat
1	Glenwood's Combination	8927	--	--	--	--
	Glenwood's Combination 7th	11892	5	+3174.0	+0.128	+176.46
	Glenwood's Combination 8th	12550	5	+2704.6	—0.200	+109.10
	Mean			+2939.3	—0.036	+142.78
2	France's Masher 2d	7248	--	--	--	--
	Imp. Masher's Galore	8572	10	+3368.9	—0.205	+149.53
	Imp. Masher's Sequel	11462	13	+2128.1	—0.373	+ 65.79
	Mean			+2748.5	—0.289	+107.66
3	Imp. Masher's Galore	8572	10	+3368.9	—0.205	+149.53
	King Masher	11084	3	+1843.3	+0.647	+178.10
	Begalore	10101	2	+1262.0	+0.225	+ 98.60
	Golden Masher	10464	3	+ 574.7	—0.190	+ 2.54
	Mean			+1226.7	+0.228	+ 93.08
4	Sheet Anchor 2d	4149	2	— 161.5	+0.790	+ 66.05
	Sultana's Sailor	7536	3	+3452.0	—0.480	+127.89
	Chantilly's Sheet Anchor	12067	4	+ 672.3	+0.820	+105.28
	Fillmore's Sultan	9117	3	+ 142.7	+0.240	+ 27.50
	Mean			+1422.3	+0.193	+ 86.89

Table Showing Transmitting Qualities of Certain Guernsey Sires to Their Sons—Continued.

No.	Name of Sire and Sons	Registry No.	No. of Pairs	Net Change in Milk	Net Change in %	Net Change in Fat
5	Guernsey Champion	8218	--	--	--	--
	Triple Champion	13067	8	+2533.7	—0.003	+133.90
	Preeminent	11690	2	+1482.5	—0.280	+ 31.60
	Mean			+2008.1	—0.141	+ 82.75
6	Dolly Dimple's May King of Langwater	12997	6	+ 924.0	+0.408	+ 92.20
	Ne Plus Ultra	15265	11	+2065.1	+0.218	+125.14
	Langwater Dictator	15068	7	+2113.6	—0.007	+121.93
	Langwater Demonstrator	16451	7	—1016.3	+0.530	— 17.67
	Mean			+1054.1	+0.247	+ 76.46
7	King of Rosendale	4488	--	--	--	--
	King of Pine Hill	7596	2	+2951.0	—0.480	+ 90.10
	King Coral	5238	6	+ 700.9	+0.298	+ 60.90
	Mean			+1826.0	—0.091	+ 75.50
8	Starlight's Excelsior	7992	10	+ 702.9	+0.073	+ 40.97
	Besom	13016	2	+1921.5	+0.535	+145.10
	Ukiah	14344	2	— 287.0	+0.075	— 7.25
	Mean			+ 817.3	+0.305	+ 68.93
9	On Guernsey Lord Mar	P.S. 1737	--	--	--	--
	Imp. Hero of the Courtilau Preel	13840	2	+ 923.0	+0.305	+ 79.85
	Imp. Lord Mar of the Prevosts	14833	4	+ 881.3	+0.033	+ 44.75
	Mean			+ 902.2	+0.169	+ 62.30
10	Glenwood Boy of Haddon	4605	20	+ 420.2	—0.332	— 9.43
	Robinson's Glenwood Boy	15638	2	+3987.5	—0.775	+131.30
	Dairymaid's Glenwood of Pinehurst	10548	2	+2495.5	—0.150	+106.30
	Dairymaid's Choice of Pinehurst	13618	6	+1616.8	—0.050	+ 85.24
	Glenwood's Stranford	9386	11	+1851.3	—0.242	+ 69.61
	Ezalia's Glenwood Boy of Ingleside	13544	2	+1316.5	—0.045	+ 55.85
	Dairymaid's King	12898	11	+ 725.8	—0.142	+ 24.61
	Glenwood's Champion	15639	12	+ 265.1	+0.009	+ 2.84
	Selma's Glenwood	12596	13	+ 52.9	—0.273	— 1.67
	Stranford's Glenwood of Pinehurst	13609	12	— 177.4	+0.033	— 1.99
	Mean			+1348.2	—0.182	+ 52.45
11	Stranford's Glenwood of Pinehurst	13609	12	— 177.4	+0.033	— 1.99
	Selma's Stranford of Pinehurst	14157	3	+ 499.4	+1.083	+148.17
	Dairymaid's Pride of Iowa	14941	4	+ 343.2	+0.165	+ 38.00
	Stranford's Glenwood of Pinehurst 3rd	16202	3	— 768.4	+0.063	— 33.80
	Mean			+ 24.7	+0.437	+ 50.79
12	Imp. Yeoman	8618	5	+ 551.0	—0.418	— 15.68
	Langwater Monarch	20899	2	+2862.0	—0.305	+117.75
	Yeoman's King of the May	17053	3	+ 208.7	+0.184	+ 32.40
	Langwater Princeling	14906	7	+1457.2	—0.843	— 12.10
	Mean			+1509.3	—0.321	+ 46.02
13	Viscount	2177	--	--	--	--
	Primitive	4909	2	+2627.0	—0.290	+107.35
	Sir Primrose	5528	2	— 32.0	+0.655	+ 58.70
	Primeval	4812	4	+ 362.5	+0.138	+ 34.25
	Corallette's Son	3987	11	— 965.6	+0.086	— 56.91
	Mean			+ 497.9	+0.148	+ 35.85
14	Rutila's Gold Basis	5625	7	+1425.9	—0.160	+ 62.84
	Ledyard Boy	11074	9	+1843.0	+0.383	+136.69
	Red Boy of Ledyard	13410	2	—1679.0	+0.170	— 65.65
	Mean			+ 82.0	+0.276	+ 35.52
15	Glenwood Main Stay	6067	16	+2127.3	—0.238	+ 74.70
	Glenwood's Main Stay 16th	9384	6	+3211.8	—0.163	+153.75
	Glenwood's Main Stay	9383	2	+1534.0	—0.235	+ 39.95
	Glenwood Boy of Waukesha	15776	2	+1074.5	—0.470	+ 9.40

Table Showing Transmitting Qualities of Certain Guernsey Sires to Their Sons—Continued.

No.	Name of Sire and Sons	Registry No.	No. of Pairs	Net Change in Milk	Net Change in %	Net Change in Fat
	Glenwood Meddler of Haddon	15748	3	+ 178.4	—0.010	+ 6.17
	Glenwood's Masher of Haddon	15529	4	+ 571.2	—0.837	— 54.10
	Mean			+1314.0	—0.343	+ 30.92
16	Main Stay	3789	--	--	--	--
	Glenwood's Main Stay	6067	16	+2127.3	—0.238	+ 74.70
	Main Stay of Belvan Heights	5804	2	— 362.0	—0.020	— 13.65
	Mean			+ 882.6	—0.129	+ 30.52
17	Standard	4652	--	--	--	--
	General Blucher	5893	2	+2937.5	+0.200	+169.00
	Starlight's Excelsior	7992	10	+ 702.9	+0.073	+ 40.97
	Capt. Robbie	7146	10	+ 71.5	—0.015	+ 1.28
	Golden Crest	7910	4	— 780.5	—0.692	— 99.15
	Mean			+ 732.9	—0.108	+ 28.02
18	Jewel of Koshkonong Place	12202	5	—1022.6	+0.092	— 39.66
	Julian of Koshkonong Place	14409	2	+1564.0	—0.300	+ 33.30
	Jury of Koshkonong Place	16793	5	+ 186.6	+0.114	+ 19.24
	Mean			+ 875.3	—0.093	+ 26.27
19	Imp. Cora's Governor of Chilmark	8971	25	+1080.7	—0.100	+ 49.13
	Justice of the Chene	11711	4	+ 212.5	+0.265	+ 34.63
	Archer of Chilmark	13376	4	+ 261.2	—0.013	+ 13.45
	Mean			+ 236.9	+0.126	+ 24.04
20	Sheet Anchor	2934	--	--	--	--
	Sheet Anchor 2d	4149	2	— 161.5	+0.790	+ 66.05
	Rutila's Sheet Anchor	5701	4	— 359.8	—0.182	— 41.27
	Mean			— 260.7	+0.304	+ 12.39
21	Rutila's Sheet Anchor	5701	4	— 359.8	—0.182	— 41.27
	Marshall of France	9051	4	+2387.5	—0.187	+ 79.85
	Pretor	9316	4	+ 998.0	+0.142	+ 62.40
	Rutiland	8399	2	+ 152.0	—0.055	— 10.15
	Pretoria's Sheet Anchor of Florham	9848	3	+ 8.0	—1.004	— 89.66
	Mean			+ 886.4	—0.276	+ 10.61
22	On Guernsey Raymond of the Preel	P.S. 1911	3	— 552.3	+0.273	— 7.00
	Imp. Jip's Raymond of Waddington	14374	7	+ 825.7	—0.140	+ 19.18
	Imp. Raymond of La Honguette	17654	2	—1073.5	+0.505	+ 1.85
	Mean			— 123.9	+0.183	+ 10.52
23	Imp. King of the May	9001	15	+1634.0	+0.015	+ 85.04
	Dolly Dimple's May King of Langwater	12997	6	+ 924.0	+0.408	+ 92.20
	Jethro Boss	11366	9	+1084.3	—0.134	+ 38.98
	May King of Ingleside	12558	15	+ 267.5	+0.037	+ 14.91
	Rhea's King of the May	14368	8	— 13.0	+0.141	+ 14.76
	King of the May's King	20489	3	—1678.3	+0.076	— 73.24
	Langwater Royal	14253	7	— 598.2	+0.004	— 29.23
	Mean			— 2.3	+0.088	+ 9.73
24	Rinaldo	8917	10	— 880.9	—0.212	— 67.06
	Old Glory	11188	3	+1927.3	+0.050	+104.24
	Guiding Star	12423	7	—2427.2	+0.260	— 91.38
	Mean			— 250.0	+0.155	+ 6.43
25	On Guernsey Imp. Masher's Sequel	P.S. 1266	--	--	--	--
	Ramee's Sequel	10463	5	+2921.2	—0.674	+ 82.16
	Imp. Spotswood Sequel	9686	9	+1504.1	—0.104	+ 64.27
	Imp. Sequel's Monogram	15649	6	+2578.0	—0.641	+ 59.55
	Imp. Spotswood Masher Sequel	9687	5	+1377.4	—0.460	+ 25.40
	Imp. His Eminence	11602	3	+1152.7	—0.300	+ 23.33
	Raymond of the Preel	11353	3	— 552.3	+0.273	— 7.00
	Imp. Galaxy's Sequel	16904	8	— 835.2	+0.244	— 12.94
	Imp. France's Jewel XI	13383	3	— 754.7	+0.010	— 34.10
	Imp. Sequel	12504	4	— 456.0	—0.277	— 43.95
	Imp. France's Jewel V	11396	2	—1678.0	—0.820	—161.80
	Mean			+ 325.7	—0.275	+ 0.89

Table Showing Transmitting Qualities of Certain Guernsey Sires to Their Sons—Continued.

No.	Name of Sire and Sons	Registry No.	No. of Pairs	Net Change in Milk	Net Change in %	Net Change in Fat
26	Guydette	3966	3	+1662.0	—0.020	+ 82.43
	Guydette, Jr.	11405	6	+1378.5	—0.223	+ 48.70
	Endymion	8916	6	+ 797.3	—0.250	+ 9.78
	Rinaldo	8917	10	— 880.9	—0.212	— 67.06
	Mean			+ 431.6	—0.229	— 2.86
27	Strong Anchor	5849	3	+ 642.0	—0.517	— 16.87
	Storm Anchor	10576	2	+ 658.0	+0.520	+ 79.45
	Roy of Norwood	8141	6	+ 862.0	—0.270	+ 16.85
	Sweet Alice King's Son	8140	2	+ 390.0	—0.190	— 2.25
	Milford Lassie 2d Anchor	8467	2	—2462.5	+0.025	—113.80
	Mean			— 138.1	+0.022	— 4.94
28	Donald of Pinehurst	5643	--	--	--	--
	Assurance of Haddon	7420	3	+ 600.7	—0.037	+ 23.56
	Glenwood Chief of Haddon	7076	3	— 235.1	+0.170	+ 1.50
	Safety of Haddon	7418	3	— 532.0	—0.137	— 39.97
	Mean			— 57.8	—0.002	— 4.97
29	Imp. May Rose King	8336	16	+1588.0	—0.071	+ 72.58
	Financier III May Rose King	13028	3	+1467.6	+0.344	+113.63
	King Francis	13500	5	+1671.0	+0.090	+ 88.34
	Imp. King of the May	9001	15	+1634.0	+0.015	+ 85.04
	Ambition	11683	5	+1060.4	+0.078	+ 60.00
	May Rose King 3d	13449	3	+ 556.0	—0.300	— 14.84
	Langwater May King	13001	2	—1025.5	+0.060	— 43.85
	King Bell	13482	3	—3632.0	+0.467	—143.13
	Manoa	11687	2	—1972.5	—0.995	—205.65
	Mean			— 39.1	—0.030	— 7.55
30	Coralette's Son	3987	11	— 965.6	+0.086	— 56.91
	Prince Edward of Lindenhurst	10476	2	— 169.5	+0.625	+ 59.55
	Council of Birchwood	10377	2	+1019.0	—0.660	— 1.45
	John Fritz	10796	2	— 882.5	—0.470	— 93.15
	Mean			— 11.0	—0.169	— 11.68
31	Raymond of the Preel	11353	3	— 552.3	+0.273	— 7.00
	Cherry's Lad of Lewison	14678	3	+1487.7	—0.266	+ 54.00
	Imp. Raynold	12178	2	+ 602.5	—0.115	+ 21.55
	Imp. Raymond of the Preel VI	14360	3	— 290.7	—0.250	— 37.30
	Imp. Raymond of the Preel II	13381	6	—2712.2	+0.309	—108.68
	Mean			— 228.2	—0.081	— 17.61
32	Gold Basis	4660	--	--	--	--
	Rutila's Gold Basis	5625	7	+1425.9	—0.160	+ 62.84
	Gold Coast	6311	2	—1326.5	—0.400	—103.55
	Mean			+ 49.7	—0.280	— 20.36
33	Imp. Royal of La Londe	6223	--	--	--	--
	Vaillantcoeur	7749	10	— 73.0	—0.231	— 17.89
	Le roi Lenfestey	7751	2	— 526.5	+0.055	— 24.20
	Mean			— 299.8	—0.088	— 21.04
34	Jethro Boss	11366	9	+1084.3	—0.134	+ 38.98
	Langwater Rival	14194	5	— 516.4	—0.118	— 29.52
	Jethro's May King of Linda Vista	14591	3	+ 322.7	—0.410	— 39.90
	Mean			— 96.8	—0.264	— 34.71
35	On Guernsey Galaxy's Sequel	P.S. 1539	--	--	--	--
	Imp. Aimable of France	13739	5	+ 758.0	+0.386	+ 84.64
	Imp. Galaxy's Lavimus	12548	12	— 955.2	+0.006	— 47.40
	Imp. Bess Sequel of the Isle	16914	3	—1793.0	—0.067	— 88.97
	Imp. Oneida's Jewel	15650	4	—1576.0	—0.130	—117.03
	Mean			— 891.6	+0.048	— 42.19
36	On Guernsey Governor of the Chene	P.S. 1297	--	--	--	--
	Imp. Gay Boy of the Isle	16998	3	+ 666.0	+0.183	+ 52.80
	Imp. Cora's Governor of Chilmark	8971	25	+1080.7	—0.100	+ 49.13
	Imp. Governor 1 of the Chene	10563	11	+ 228.2	+0.207	+ 42.94
	Imp. The Conqueror II	15323	3	+ 231.7	—0.686	— 56.54
	Imp. Old Paddy	16903	3	—4529.3	—0.530	—343.17
	Mean			— 464.5	—0.185	— 50.96

Table Showing Transmitting Qualities of Certain Guernsey Sires to Their Sons—Concluded.

No.	Name of Sire and Sons	Registry No.	No. of Pairs	Net Change in Milk	Net Change in %	Net Change in Fat
37	Skeezicks	9979	9	— 217.0	—0.169	— 29.04
	Increase	12459	3	—1215.3	+0.373	— 34.70
	Yeksa's Unique	13123	3	—1364.3	+0.027	— 76.60
	Mean			—1289.8	+0.200	— 55.65
38	Penwyn 2d	7559	5	+ 279.8	—0.202	— 1.32
	Knight of Gold	10836	4	— 992.5	+0.290	— 24.12
	Penwyn of Rosendale	11282	3	—1274.3	—0.283	— 98.10
	Mean			—1133.4	+0.003	— 61.11
39	Count Lonan	3516	2	—2020.0	—0.150	—158.40
	Aeneas	5853	5	+1159.2	—0.604	+ 4.34
	Wolfram	5640	4	—3929.2	—0.002	—219.07
	Mean			—1385.0	—0.303	—107.37
40	Imp. Sequel's Monogram	15649	6	+2578.0	—0.641	+ 59.55
	Imp. Sequel's Champion	16919	2	— 520.0	—0.595	— 92.95
	Imp. Clara's Sequel	29414	2	—3436.5	+0.035	—150.75
	Mean			—1978.3	—0.280	—121.85

This table shows that, of the bulls having two or more sons tested by their progeny performance test, 25 have increased the butter-fat of their sons' daughters over what the dams of these daughters produced. Fifteen of the sires lowered the butter-fat production of their sons' daughters as compared with the dams of their sons' daughters.

Of the sires whose sons raised the butter-fat production of their daughters, Glenwood's Combination 8927 proved the best with 142.78 pounds of butter-fat as the mean increase of his sons. A fairly close second to this sire was France's Masher 2d 7248. His sons raised the butter-fat of their daughters 107.66 pounds over that of the dams of these daughters. For those sires with more than two sons Dolly Dimple's May King of Langwater progeny performance made the best showing. The sons in this case were Ne Plus Ultra, Langwater Dictator and Langwater Demonstrator. Glenwood's Boy of Haddon had 9 sons under test. This sire's sons increase the butter-fat of their daughters over that of their dams 52.45 pounds.

The same caution should be given for the use of this table that was expressed in last year's report. It should always be remembered that this table takes no cognizance of the absolute milk production of the dams; it only concerns itself with the question of whether the dam's record was higher than that of the daughters in determining the merits of a sire. The bull at service in a herd of high producing dams would consequently be more likely to lower the milk production of his daughters than a bull at service in a herd of low producing dams . It is true however that the man who owned the high producing herd would probably be wise to get rid of the bull failing to maintain this herd's production in its daughters.

THE VARIATION OF THE MILK OF AYRSHIRE COWS IN QUANTITY AND FAT CONTENT OF THEIR MILK.

As previously pointed out the study of existing milk records has been actively pushed. These studies on Scottish Ayrshires include a study of the relation which exists between age and milk yield and age and butter-fat percentage. It was found that in these Ayrshire cattle the absolute amount of milk produced per unit of time increases with the age of the cow until a maximum is reached, but the amount of increase diminishes each year with advancing age until the absolute maximum of production is reached. After the time of maximum productivity the absolute production per unit of time decreases with advancing age, and by a continually increasing amount.

The butter-fat percentage was found to decrease regularly from two years to ten years. From ten years on the rate of decline was somewhat less than it was from two to ten years.

The variability of the mixed milk of a large herd was compared with that of the individual milk yield of the Ayrshire. It was found that the variation of the mixed milk was 9 whereas the variability was 17 to 25 when individuality of the Ayrshire cows was at play. These figures as they stand suggest that roughly about one-half of the variation (measured by the coefficients of variation) in milk yield results from the varying inherited constitution for milk production of the animals in respect of this character, and the other half results from the varying external circumstances to which cows are subjected during lactation and which have an effect upon the flow of milk. Or, to put the matter in another way, if the conclusion just stated were true it would mean that if a large number of cows were placed in environmental circumstances which were at once ideal and uniform we should expect the variation exhibited in milk production to be roughly about one-half of that which we actually find when we measure this variation under ordinary circumstances.

In the case of fat content of milk, individuality has clearly much more to do with determining variation. Here the effect of the environment is extremely small.

THE ACCURACY WITH WHICH THE MILK PRODUCTION OR BUTTER-FAT PERCENTAGE OF ONE LACTATION DESCRIBES MILK PRODUCTION OR BUTTER-FAT PERCENTAGE OF SUBSEQUENT LACTATIONS.

The dairyman often asks this question as he looks over the lactation record of one of his cows, will it pay to keep this cow for another year? Such a question involves three questions; (1) what amount of milk did the cow produce in the lactation above referred to; (2) what was the cost of maintaining the cow; (3) what reliance may be placed on the milk yields of one lactation as a measure of the milk yield of a subsequent lactation.

The first and second of these questions are those which the dairyman can answer for each and every cow in his herd by keeping a record of the cost and return on each cow. A good deal of uncertainty appears to exist as to how far one lactation is a measure of the milking capacity of future lactations. During the past year extensive records on a pure bred herd of Jersey cattle have been analyzed to determine this point.

The records included 88 cows which had completed five lactation periods between the ages of 2 years and 8 years. Each record was for the first eight months of the lactation period. In each of these records the level of each cow's record in the first lactation was determined in relation to the level in the total milk production for the first five lactation periods. It was found that the relative rate of milk production remained very nearly the same for the total milk produced by a cow in her first five lactation periods as it did in her first lactation. That is, if the heifer was a high producer in her first lactation she also was a high producer in the total production of her first five lactations. If she was a medium producer she was only a medium producer in these lactations. If she was a poor producer in the first lactation she was also a poor producer in all five lactations. Relatively the cows stayed very close to the plane of production established by their first lactation for the total of the other lactations. The correlations measuring these relations are given in table 2.

TABLE 2.

Correlation Coefficient for the Milk Yield (8 Months of Lactation) of a Lactation of a Given Age and the Milk Yield for the First Five Lactations of the Cow's Life.

Age when Lactation Commenced	Mean Milk Yield for that Lactation	Standard Deviation of Milk Yield	Correlation Coefficient for Lactation Records and the first five Lactation's Total Yield
2 years to 3 years	4159.1± 57.8	803.2± 40.8	+0.742±.032
3 years to 4 years	4840.9± 86.1	1197.9± 60.9	.842±.021
4 years to 5 years	5380.7± 78.8	1096.2± 55.7	.861±.019
5 years to 6 years	5568.2± 87.1	1211.2± 61.6	.825±.023
6 years to 7 years	5681.8± 91.4	1270.7± 64.6	.821±.023
Total of first five lactations	25613.6±335.9	4672.0±237.5	

From this table a simple arithmetrical equation can be found to predict the lactation of the five lactations from the lactation of any age. These equations are:

Five year total lactation yield=7671.9+4.31x two year lactation yield.
Five year total lactation yield=9719.5+3.28x three year lactation yield.
Five year total lactation yield=5861.4+3.67x four year lactation yield.
Five year total lactation yield=7893.5+3.18x five year lactation yield.
Five year total lactation yield=8471.9+3.02x six year lactation yield.

These results may best be put in tabular form for ease in reference. In the table that follows the two year old lactation record is chosen because it represents the most frequent record in normal dairy practice.

TABLE 3.

Actual Milk Production of Two Year Old Cows (8 Months of Lactation) and the Expected Five Lactation Yield.

Actual Milk Production	Expected Five Lactation Yield
1375 to 1625	14143
1625 to 1875	15221
1875 to 2125	16300
2125 to 2375	17378
2375 to 2625	18457
2625 to 2875	19535
2875 to 3125	20614
3125 to 3375	21692
3375 to 3625	22770
3625 to 3875	23849
3875 to 4125	24927
4125 to 4375	26006
4375 to 4625	27084
4625 to 4875	28163
4875 to 5125	29241
5125 to 5375	30320
5375 to 5625	31398
5625 to 5875	32477
5875 to 6125	33555
6125 to 6375	34634
6375 to 6625	35712

Similar information to that given above for milk production has been analyzed and the results made available for the percentage of butter-fat. The records for analyses were the same as those used for the milk yield just given. The relation which exists between the average butter-fat percentage of the first five lactations and the butter-fat percentage of the individual lactations is given in the table 4. This table has the same arrangement as table 3.

TABLE 4.

Correlation Coefficients for the Butter-fat Percentage of a Lactation at a Given Age and the Butter-fat Percentage for the First Five Lactations of a Cow's Life.

Age when Lactation Commenced	Mean Milk Yield for that Lactation	Standard Deviation of Milk Yield	Correlation Coefficient for Individual Lactation Records and the first five Lactation's Total Yield
2 years to 3 years	5.25±.04	0.49+.03	+0.797±.026
3 years to 4 years	5.23+.04	.49±.03	.836+.022
4 years to 5 years	5.29±.04	.50+.03	.862+.018
5 years to 6 years	5.23+.03	.46±.02	.857+.019
6 years to 7 years	5.18+.03	.43+.02	.784+.028
Five lactation butter-fat percentage	5.22±.03	.40+.02	

From these results the equations for the prediction of the average butter-fat percentage of the five lactations have been found. These are given below.

Average butter-fat percentage for five lactation yield=1.819+.648x 1st lactation
Average butter-fat percentage for five lactation yield=1.621+.688x 2nd lactation
Average butter-fat percentage for five lactation yield=1.591+.685x 3rd lactation
Average butter-fat percentage for five lactation yield=1.349+.740x 4th lactation
Average butter-fat percentage for five lactation yield=1.406+.736x 5th lactation

The solution of the first equation has been made of the butter-fat percentage at two years to determine the expected butter-fat percentage for the five lactation periods. These results are given in table 5.

TABLE 5.

Actual Butter-fat Percentages of Two Year Old Cows and the Expected Five Lactation Butter-fat Percentage.

Actual Two Year Butter-Fat Percentage	Expected Butter-Fat Percentage for the First Five Lactations
3.75—3.85	4.281
3.85—3.95	4.346
3.95—4.05	4.411
4.05—4.15	4.476
4.15—4.25	4.541
4.25—4.35	4.605
4.35—4.45	4.670
4.45—4.55	4.735
4.55—4.65	4.800
4.65—4.75	4.865
4.75—4.85	4.929
4.85—4.95	4.994
4.95—5.05	5.059
5.05—5.15	5.124
5.15—5.25	5.189
5.25—5.35	5.253
5.35—5.45	5.318
5.45—5.55	5.383
5.55—5.65	5.448
5.65—5.75	5.513
5.75—5.85	5.577
5.85—5.95	5.642
5.95—6.05	5.707
6.05—6.15	5.772
6.15—6.25	5.837
6.25—6.35	5.901
6.35—6.45	5.966
6.45—6.55	6.031
6.55—6.65	6.096
6.65—6.75	6.161
6.75—6.85	6.225
6.85—6.95	6.290
6.95—7.05	6.355

From these data it is possible to determine the expected butter-fat of the first five lactations. First determine the expected milk yield and the expected butter-fat percentage of the first five lactations. The product of these two constants will, of course, give the expected butter-fat.

The results above given are, of course, only strictly applicable to the Jersey and related breeds. They are further only applicable to these breeds when the average milk production and butter-fat percentage for the first eight months of lactation equal or nearly equal the averages given in tables 2 and 4 for the years under consideration.

THE TRANSMITTING QUALITIES OF JERSEY SIRES FOR MILK YIELD, BUTTER-FAT PERCENTAGE AND BUTTER-FAT.

A bulletin to be published shortly gives the detailed information pertaining to this subject. These results may briefly be summarized as follows. The objective of this study is a "Progeny Performance" analysis of the American Jersey Registry of Merit Sires, to ascertain the nature of their transmitting qualities for milk production, butter-fat percentage and butter-fat. Two hundred and twenty-five sires meet the requirements of this test. One thousand eighty-one Registry of Merit daughters with their 810 test dams are included in these data.

The milk production, butter-fat percentage and butter-fat of these daughters in relation to that of their dams was studied first as a whole and second to determine the transmitting qualities of their sires individually. It was found that taking the daughters as a whole the average corrected milk production was 9547.6±44.7; the dam's milk production as a whole was 9391.9 ±51.5. The difference in favor of the daughters was consequently 155.7±68.2. This difference is certainly not significant. The daughters' average butter-fat percentage was 5.558±.011 and their dams was 5.625±.013. The difference is therefore against the daughters 0.067±.017 or the difference is 3.9 times the probable error. These facts lead to the conclusions that the mean milk production of the daughters of Registry of Merit cows does not differ from that of their dams in milk production and that to a small degree these same daughters are slightly lower in butter-fat percentage than are the dams from which they came.

The populations of the daughters' milk production and butter-fat percentage were divided into four equal divisions as to numbers contained therein. The same was done for the dam's population of milk production and butter-fat percentage. These parts were designated A the highest milk production or butter-fat percentage as the case may be, B the next highest, C the next lowest, and D the lowest. The relative milk production or butter-fat percentage of each daughter-dam pair has been determined in this manner. The position of the dam is placed first and the position of the daughter second. Thus a record AB for milk production states that the dam's milk production was above 10403 pounds and the daughter's milk production between 9312 and 10780 pounds.

With these preliminary facts in mind the data may be given on the individual transmitting power of the sires. There are 224 Jersey Registry of Merit sires which meet the requirements of this performance test for their transmitting qualities in milk production. One hundred and five of these sires or less than one-half raise the milk production of their daughters over that of the dams of these daughters. The largest number of daughter-dam pairs is 39 for the sire Hood Farm Pogis 9th, 55552. Of those sires which have a large number of pairs Hood Farm Torono, 60326 with 34 pairs stands first in his transmitting qualities raising the milk production of his daughters on the average 26201 pounds. The relative milk productions of his daughter-dam pairs on a percentage basis are 26 AA—3 AB —9 BA —3 BC —32 CA —9 CB —9 DA —3 DB —3 DC. Described in words, this bull was bred to 26 per cent of the highest group of milking cows and produced 26 per cent of the highest group of milk daughters; bred to 3 per cent of the highest group of milking cows he produced 3 per cent of the second highest group of daughters, etc.

The next sire with a good number of daughters was Spermfield Owl. This bull with 26 daughter-dam pairs raised the milk production of these daughters on the average 1695.7 pounds. The relative milk productions of his daughter-dam pairs on a percentage basis are 12 AA—4 AB+4 AC+23 BA +12 BB+4 BC+8 CA+8 CB+4 CD+12 DA+4 DB+8 DD.

Among the other sires standing well up in the lists might be mentioned Queen's Raleigh, 88232; Sans Aloi 81012; Ternisia's Interested Prince 71698; The Plymouth Lad 89792; and Chief Engineer 47148.

Two hundred and twenty-five sires are included in the sires which met the requirements of the daughter-dam performance test for transmitting qualities of butter-fat percentage. Out of this number 101 sires raised the butter-fat percentage of their daughters' milk as compared with the butter-fat percentage of the dams of these daughters.

The leading sire in this butter-fat percentage performance test was Clear Brook Chief 74685 raising his daughter on the average 1.338 per cent of butter-fat. This sire had two daughter-dam pairs. The dams were both in the lowest group for butter-fat percentage (class D) and this sire raised his daughter from these dams to the highest group (class A).

Among the sires with a fair number of daughter-dam pairs which raised the butter-fat percentage to a marked degree might be mentioned Irene's King Pogis 73182; Merry Maiden's Grandson 71003; Pogis 75th of Hood Farm 94501; Jacob's Emanon 84177; and Golden Fern's Son 78687.

Hood Farm Pogis 9th leads in number of daughter-dam pairs with 42. This bull raised the butter-fat percentage of his daughter on the average of 0.243 per cent over the butter-fat percentage of the dams of their daughters.

The sires mentioned as superior in the milk transmitting ability, Hood Farm Torono and Spermfield Owl, do not check up so well in their ability to transmit high butter-fat percentage. Hood Farm Torono caused his daughter on the average to be 0.225 per cent of butter-fat below what the dams of these daughters produced. Spermfield Owl only raised his daughters on the average 0.027 per cent of butter-fat over what the dams of these daughters produced.

There are 224 sires of known transmitting ability for net butter-fat given. Of this number only 99 sires raise the butter-fat production of their daughters over that of their dams. The sires which raised the production of their daughters' butter-fat most were Sans Aloi 81012, Signal's Successor 72758, and Golden Glow Chief 61460. The sires which made the deepest impression on the breed by raising the butter-fat of the largest number of daughters over that of their dams was Hood Farm Torono with 34 pairs and an average increase for each daughter of 121.51 pounds. The next bull, Spermfield Owl, with 26 pairs raised the butter-fat production 97.71 pounds on the average for each of his daughters. Some of the bulls lowering the production of their daughters markly were Gertie's Son of Washington 83799, Hood Farm S. Tormentor 96311, and Oxford Lad's Owl 75599.

The information summarized above was arranged to reveal the transmitting qualities for milk production, butter-fat percentage and butter-fat of Jersey sires to their sons. There were in this table 159 sires which had sons whose progeny performance was known. Of this number 69 or significantly less than half had sons who raised the butter-fat production of their daughters over that of their dams. Among these sires who had sons of merit Signal's Crown Prince 61621 and Chief Engineer 47148 are the leaders. Among those sires whose sons lowered the butter-fat productions of their daughters may be mentioned Merry Maiden's Grandson 91003 and Ethleel 2d's Jubilee 18249.

The sires of superior merit are defined as those which raise the milk production and butter-fat percentage of their daughters as compared with that of their dams. The inferior sires are defined as those sires who lower the milk production and butter-fat percentage of their daughters as compared with the same variables in their dams. The superior sires so defined are arranged by the amount of butter-fat that they increase the production of their daughters over that of their dams. The inferior sires are classified according to the amount of butter-fat that they decrease the production of their daughters in comparison with that of their dams. These two groups of sires are subjected to four generation pedigree analysis to determine their inbreeding and relationship, the amount of Island and American stock, "males and females" and "on the sire's side of the pedigree and on the dam's side of the pedigree," and the individual animals most frequently repeated in the two groups of pedigrees.

There are 28 sires in the group of sires superior in their transmitting qualities for milk production and butter-fat percentage. In the group of sires inferior in their transmitting ability for these two characters there are 47 sires, a ratio of 1 to 1.7. Such a difference speaks for itself. It emphasizes with startling clearness the need of exact knowledge of the transmitting qualities of bulls to be bred as sires and of the necessity for exact knowledge of the inheritance of milk production and butter-fat percentage.

The inbreeding coefficients show that the sires of superior merit are 7.08 per cent of the greatest possible inbreeding up to the fifth generation. The inferior sires are inbred 9.65 per cent of the greatest possible amount (continued brother and sister mating). The group of sires poorer in their transmitting qualities are consequently more inbred than the group of sires with superior transmitting qualities.

The analysis of the pedigrees for the amount of relationship that may exist between the sires and dams of the individual bulls in the superior group and in the inferior group shows that there is little or no difference in the amount of this relationship within the two groups.

The resolution of the four generation pedigree into the Island bred Jerseys and by difference American bred Jerseys showed the mean number of Island males in the pedigrees of the superior sires group to be 8.07 and the mean number of females 7.79. The mean number of Island bred males in the inferior sires group were shown to be 6.94 and the mean number of females 6.55. The group of sires which increased the production of their daughters over that of their dams had, consequently, more Island bred stock in their pedigrees. The females in each group of the pedigrees had a less proportion of Island bred individuals than the males had in each of the groups.

This same information on Island bred animals is revealed when classified as to whether the animals occur on the sire's or dam's side of the pedigree that the superior sires have by a small percentage more Island bred animals in the sire's side of their pedigree than do the inferior sires and that the superior sires have a larger number, probably significantly larger number of Island ancestors in the female side of the pedigree than do the inferior sires. The figures are 8.82 to 8.19 and 7.04 to 5.30. The number of ancestors of Island breeding on the sire's side of the pedigree is in both cases larger than the number of Island bred ancestors on the dam's side of the pedigrees.

These conclusions are further substantiated by a study of the proportion of Island ancestors in the great-great-grand-parents of these two groups of sires.

Study of the pedigrees of these two groups of sires discloses the fact that all the animals which appeared in the pedigrees of the superior sires on the male side of the pedigrees more than four times or on the female's side of the pedigree more than three times also had appearances in the pedigrees of the sires inferior in their transmitting qualities. This fact alone makes it clear that the appearance of certain famous animals in a pedigree of a given bull is no guaranty of that particular bull's worth.

CONFORMATION AND ITS RELATION TO MILK PRODUCING CAPACITY.

Of the means for selecting dairy cows for the herd perhaps no other occupies as important a place as the conformation of the cow herself. The general opinion has grown up that certain parts of the body have greater value than others as a guide to milk production. During the last year the author has analyzed 1674 records for Jersey cattle* where the score, as judged by some 140 men well known in the dairy industry, was recorded for each part of the body commonly considered an indication of milk production. On all of these cows the record for milk production was known through the Registry of Merit tests. The points considered and the relation they had to milk production are shown in table 6.

Correlation coefficients for milk yield with the conformation as a whole and for the various parts were determined. The correlation coefficients ranged from $-0.0697 \pm .0165$ to $0.1941 \pm .0160$. Out of the 19 correlations only one was minus in value; 17 were more than three times their probable error. The total score had the highest correlation with milk yield. The parts of the conformation having a distinctly significant relation

*It is a pleasure to acknowledge the indebtedness of the author to Mr. R. M. Gow, Secretary, American Jersey Cattle Club, in furnishing a set of these score cards for this investigation. We are most grateful for the courtesy and cooperation shown by him and the officials under him.

TABLE 6.

Correlation between Conformation and Milk Yield.

Characters Correlated	Correlation Coefficient	Correlation Coefficient P.C.r
Milk yield and Total score	0.1941±.0160	12.13
Milk yield and Milk veins—Large, tortuous and elastic	0.1908±.0160	11.93
Milk yield and Udder—Large size and not fleshy	0.1906±.0160	11.91
Milk yield and Udder—Rear udder well rounded, and well out and up behind	0.1710±.0161	10.62
Milk yield and Body—Wedge shape, with deep, large paunch, legs proportionate to size and of fine quality	0.1657±.0161	10.29
Milk yield and General Appearance—Symmetrical balancing of all the parts, and a proportion of parts to each other, depending upon size of animal, with the general appearance of a high-class animal, with capacity for food and productiveness at pail	0.1147±.0164	6.99
Milk yield and Body—Thighs flat and well cut out	0.0885±.0164	5.40
Milk yield and Body—Rump long to tail-setting and level from hip-bones to rump-bones	0.0862±.0165	5.22
Milk yield and Udder—Fore udder full and well rounded running well forward of front teats	0.0777±.0165	4.71
Milk yield and Teats—Of good and uniform length and size, regularly and squarely placed	0.0671±.0165	4.07
Milk yield and Head—Medium size, lean; face dished; broad between eyes and narrow between horns	0.0671±.0165	4.07
Milk yield and Tail—Thin, long, with good switch, not coarse at setting on	0.0634±.0165	3.84
Milk yield and Udder—Broad, level or spherical, not deeply cut between teats	0.0615±.0165	3.72
Milk yield and Size—Mature cows, 800 to 1,000 pounds	0.0611±.0165	3.70
Milk yield and Body—Hip-bones high and wide apart; loins broad, strong	0.0589±.0165	3.57
Milk yield and Neck—Thin, rather long, with clean throat; thin at withers	0.0499±.0165	3.02
Milk yield and Head—Eyes full and placid; horns small to medium, incurving; muzzle broad, with muscular lips; strong under jaw	0.0419±.0165	2.54
Milk yield and Body—Lung capacity, as indicated by depth and breadth through body, just back of fore legs	0.0222±.0166	1.34
Milk yield and Body—Back straight to hip-bones	−0.0697±.0165	4.22

to milk production of the cow were the milk veins, size and condition of udder, the size and shape of rear udder, the shape and size of barrel and the general appearance of the cow.

These correlation coefficients are on the whole quite low. In this connection it is of interest to compare the relative value of correlation coefficients with those for actual milk yields over short periods. The problem may be stated thus.

a. What is the relation between the milk production of a short period (say 7 days) in a lactation and that for the whole lactation?

b. What is the relation between the milk production of a short period and the milk production of a subsequent whole lactation of which the short period is not a part?

In answering this question the author quotes from some unpublished data soon to be put in bulletin form.

The range in values of the correlation coefficients for milk yield of the seven day test with the milk yield of the year test in another lactation is +0.3351 to +0.8470. For the seven day test with the year test of the same lactation the range is —0.1157 to +0.8470. For the parts considered in determining the conformation the range is +0.1941 to —0.0697.

The average correlation coefficient for the 7 day test of Holstein-Friesian cattle and the 365 day test of which the seven day test is a part is +0.570. The average correlation coefficient for the 7 day test and 365 day test of which the 7 day test is not a part is +0.550. In other words a seven day test is a much better measure of a cow's ability at the pail than is the total score or any part of the cow's conformation as judged by the average trained dairyman. This general relation between the milk yields of the various length of periods has been found to hold for the other breeds.

Breeding Experiments.

The experiments in cattle breeding which have been carried out in cooperation with the University of Maine have progressed satisfactorily this year. These experiments, as pointed out in previous reports, are definite crossbreeding experiments so planned as to furnish data on the inheritance of milk, butter-fat and butter-fat per cent. The object of this work is consequently not to obtain an animal which shall be a high milker with a high percentage of butter-fat but rather to determine the laws of heredity behind the transmission of these qualities. In this way and in our present knowledge in this way only can the breeding for better dairy cattle within the different breeds be intelligently accomplished.

The most important results come in the second hybrid generation from the pure bred parents. The breeding work of this year has been devoted largely to the production of these second generation females. To November 3, 1919, 13 such cows have been produced.

Twenty-six first generation hybrids now make up the herd. To make this herd complete it may be necessary to add two more animals to this number.

Milk records are now being obtained on the first generation females. Fourteen of these cows are now in milk for their first lactation or have already completed this lactation. Three of the second generation cows are now in milk.

The complete list of the calves which have been born into the crossbred herd from October 15, 1918 to November 3, 1919 is shown in table 7. This list together with those of previous reports will give the crossbred animals thus far obtained.

The milk production of the first generation hybrids is of interest as it gives the first clue to the milk production which may be expected from a cow known to have a high milk production inheritance from one side and a low milk production inheritance from the other side. Of such a cow the question is often asked, will the milk production be like the high producer, will it be like the low producer or will it be a blend somewhere between? Figures 3 to 9 give the milk yields of the first generation crossbred, the milk yields of their dams and the milk yield corresponding to the transmitting ability of the sire. These yields are on a monthly basis.

All records for the crossbreds have been corrected to the expected milk yield at an age basis of 2 years. If the crossbred daughter has lactation records at say 2 years, 3 years and 4 years the record for 3 years is corrected to the expected record at 2 years and the 4 years record to the expected record at 2 years. These three records are then summed and the average taken. This average is the record used as the milk production of the crossbred.

The record for the dam is obtained in a similar manner to that of the daughter.

TABLE 7.

Calves Which have been Produced in the Hybridization Experiments between October 15, 1918 and October 26, 1919.

Calf No.	Sex	Dropped	Sire's Name and Registry Number	Breed of Sire	Dam's Name and Registry Number	Breed of Dam
69	♂	October 16, 1918	Crossbred No. 31	Jersey x Aberdeen Angus	Crossbred No. 27	Jersey x Aberdeen Angus
70	♂	October 16, 1918	Crossbred No. 32	Aberdeen Angus x Guernsey	Rosalie	Jersey
71	♀	December 2, 1918	Crossbred No. 17	Aberdeen Angus x Jersey	Crossbred No. 15	Jersey x Aberdeen Angus
72	♀	January 2, 1919	Envious Majestic (17526)	Ayrshire	Ruthena's Poetess	Jersey
73	♂	January 21, 1919	Taurus Creamelle Hengerveld (98482)	Holstein-Friesian	Eventime 4th (155526)	Aberdeen Angus
74	♀	January 27, 1919	Lakeland's Poet (102603)	Jersey	Crossbred No. 34	Jersey-Holstein-Friesian x Jersey
75	♀	February 2, 1919	Kayan (167617)	Aberdeen Angus	Lakeland's Lassie (379557)	Jersey
76	♀	February 3, 1919	Crossbred No. 32	Aberdeen Angus x Guernsey	Crossbred No. 29	Aberdeen Angus x Guernsey
77	♂	February 11, 1919	Crossbred No. 9	Aberdeen Angus x Holstein-Friesian	Orono Madge (192781)	Aberdeen Angus
78	♂	February 14, 1919	Envious Majestic (17526)	Ayrshire	Crossbred No. 37	Aberdeen Angus x Ayrshire
79	♂	March 9, 1919	Crossbred No. 35	Holstein-Friesian x Jersey	Crossbred No. 1	Jersey x Holstein-Friesian
80	♂	March 11, 1919	Nepaul (23330)	Guernsey	Crossbred No. 22	Aberdeen Angus x Guernsey
82	♂	July 31, 1919	Lakeland's Poet (102603)	Jersey	Crossbred No. 25	Jersey-Holstein-Friesian x Jersey-Holstein-Friesian
83	♀	August 3, 1919	Lakeland's Poet (102603)	Jersey	Crossbred No. 11	Jersey x Holstein-Friesian
84	♂	August 5, 1919	Lakeland's Poet (102603)	Jersey	Crossbred No. 42	Jersey x Holstein-Friesian
85	♀	August 31, 1919	Crossbred No. 31	Jersey x Aberdeen Angus	Crossbred No. 27	Jersey x Aberdeen Angus
86	♂	September 8, 1919	Crossbred No. 30	Holstein-Friesian x Aberdeen-Angus	Crossbred No. 44	Holstein-Friesian x Aberdeen Angus
87	♀	September 12, 1919	Crossbred No. 17	Aberdeen Angus x Jersey	Crossbred No. 16	Aberdeen Angus x Jersey
88	♂	September 29, 1919	Nepaul (23330)	Guernsey	Crossbred No. 12	Holstein-Friesian x Guernsey
89	♂	September 29, 1919	Kayan (167617)	Aberdeen Angus	Crossbred No. 47	Holstein-Friesian x Aberdeen Angus
90	♀	October 6, 1919	Crossbred No. 9	Aberdeen Angus x Holstein-Friesian	Crossbred No. 45	Aberdeen Angus x Holstein Friesian

The records for the sires Taurus Creamelle Hengerveld and Lakeland's Poet are obtained as follows. The records of all daughters of these sires from dams of their own breeding are obtained in similar manner to that described for the crossbred females. These records showing the milk production of each daughter of a given sire are then summed and the mean taken. This mean is used as the sire's potential transmitting ability. The measure used is consequently the progeny performance test for the hereditary composition of the sire for milk production.

The composition for milk production transmission of the bulls, Delva's University De Kol and Kayan, where no pure offspring are available is determined as follows. For Delva's University De Kol, Taurus Creamelle Hengerveld's test is used since they are bulls of the same breed. Kayan's milk producing capacity is taken as that of the pure bred Aberdeen Angus in the herd.

Figure 27 shows the milk record on a monthly basis of Crossbred Number 1 corrected to the two year basis. This record is shown as the solid line ———. The mating to produce this crossbred was a Jersey bull, Lakeland's Poet 102603, bred to a Holstein-Friesian cow, Pauline Posch 81048. The milk production on a monthly basis corrected to the 2 year age expectation is given as the dotted line – – – – –. The expected potential milk production of the Jersey sire is given as a dot and dash line ——— – ———. The milk production of the crossbred clearly follows that for the sire's expectation. The milk production of the Holstein-Friesian dam follow a course much higher than does that of the crossbred daughter. The daughter may therefore be said to have only the inheritance of the low milk producing breed. In view of what follows in these curves this result is somewhat surprising. The result cannot, however, be a mistake for three reasons. The crossbred daughter's milk production is based on four lactations. The milk production of the Holstein-Friesian dam is based on 11 lactations. It is further interesting to note in this connection that Crossbred No. 45 now beginning her lactation, a cross using the same dam but an Aberdeen Angus sire is also milking lower than would be expected. It seems therefore in view of these facts that there is something in this cow's transmitting ability

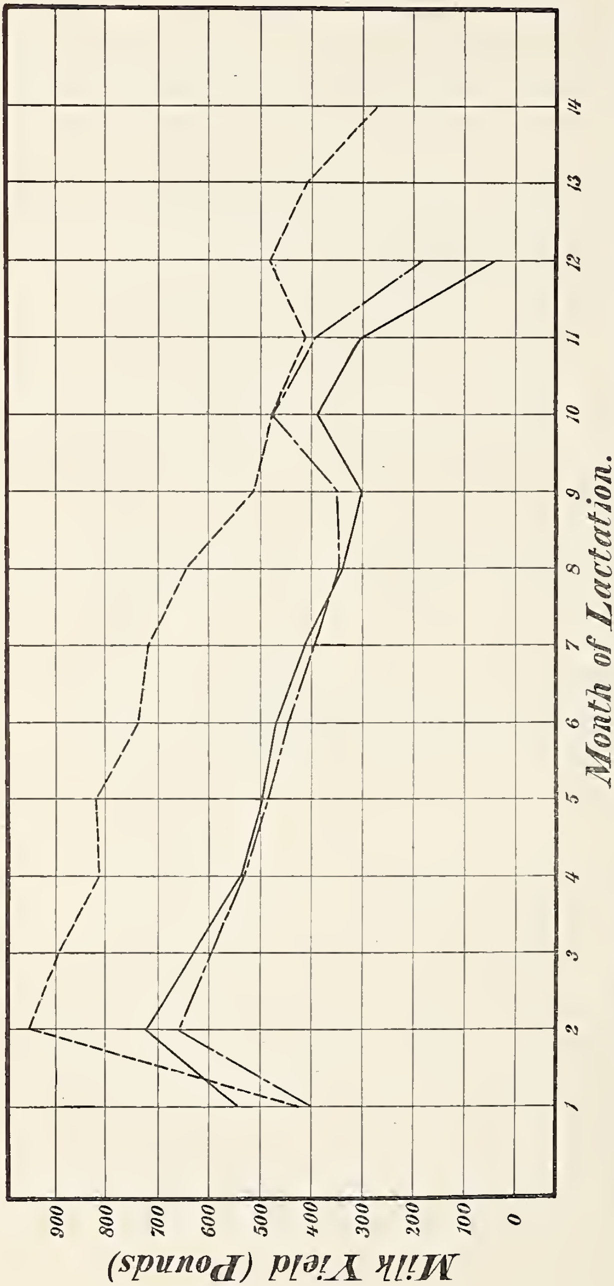

FIGURE 27. Curves showing the milk production of Crossbred No. 1 in conjunction with that of her dam Pauline Posch (Holstein-Friesian) and her sire Lakeland's Poet (Jersey). The significance of the curves is ———Crossbred #1 monthly production; ‒‒‒‒‒‒‒Pauline Posch monthly production and ——— ‒ ‒ ——— Lakeland's Poet's potential production.

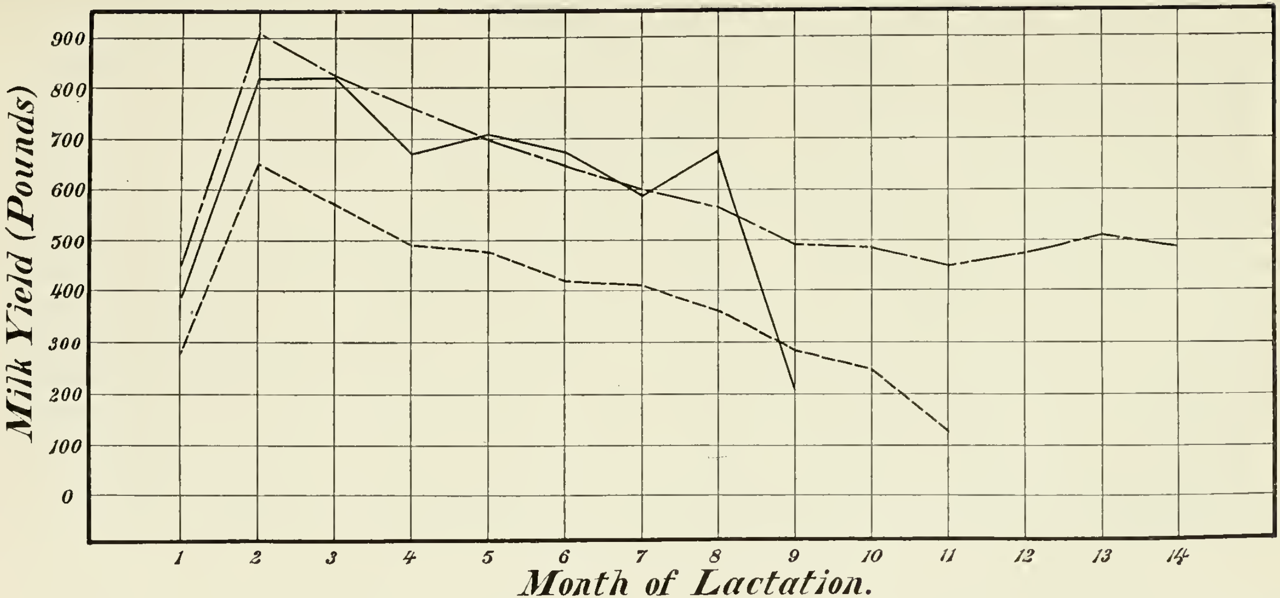

Figure 28. Curve showing the milk productions of Crossbred No. 2 in conjunction with that of her dam Canada's Creusa, Guernsey, and her sire Delva's University DeKol 133910, Holstein-Friesian. The significance of the lines is the same as that in the previous figure; ———Crossbred; ------ pure bred dam; and ——— - ——— - pure bred sire.

for milk production which may lead to low milk production in her daughters. This possibility will be considered further.

Figure 28 shows the milk production of Crossbred No. 2 on a monthly basis. The significance of the three different lines is the same as that for figure 27. Crossbred No. 2 record is unfortunately based on only one lactation record. The record for Canada's Creusa is based on five lactation records. The record for the sire is that of the Holstein-Friesian milk production for this herd at 2 years as previously described. The curve for the milk production of Crossbred No. 2 clearly follows that of the Holstein-Friesian, or the high milk producing breed. The continuation of the lactation from the eight months on for Crossbred No. 2 would clearly follow that of the Holstein-Friesian parent. Unfortunately this record is not available as the cow on the tuberculosis test showed a temperature, was judged tubercular and killed. Her autopsy did not however show any lesions which were noticeable. Her record is, therefore, insofar as it goes representative.

The milk production of Crossbred No. 11 is clearly intermediate between that of her dam Delva Johanna DeKol 146774 and her sire Lakeland's Poet 102603 for the first three months of lactation. From the time on this cow follows closely the milk production of the high milking parent Delva Johanna DeKol. The records of the crossbred cow and her pure bred dam are probably not quite representative. The crossbred record consisted of the average of two corrected records, that of the Holstein-Friesian dam consisted of the average of seven corrected records. Inasmuch as the crossbred cow, No. 11, had a much better corrected two year old record from the three year old lactation than she did from her two year old lactation, it probably means that her milk yield as shown in figure 30 is not quite representative of her capacities. This might well be so because she started her first lactation before her growth was anywhere near completed. In any case the answer to this hypothesis will come in future lactation records. As it stands at present, therefore, the only conclusion that can be drawn is that the milk production of the crossbred is lower than that of her dams for the first four months of lactation. From this point the milk production is approximately the same, that is, follows closely or equals the milk yield of her high producing parent.

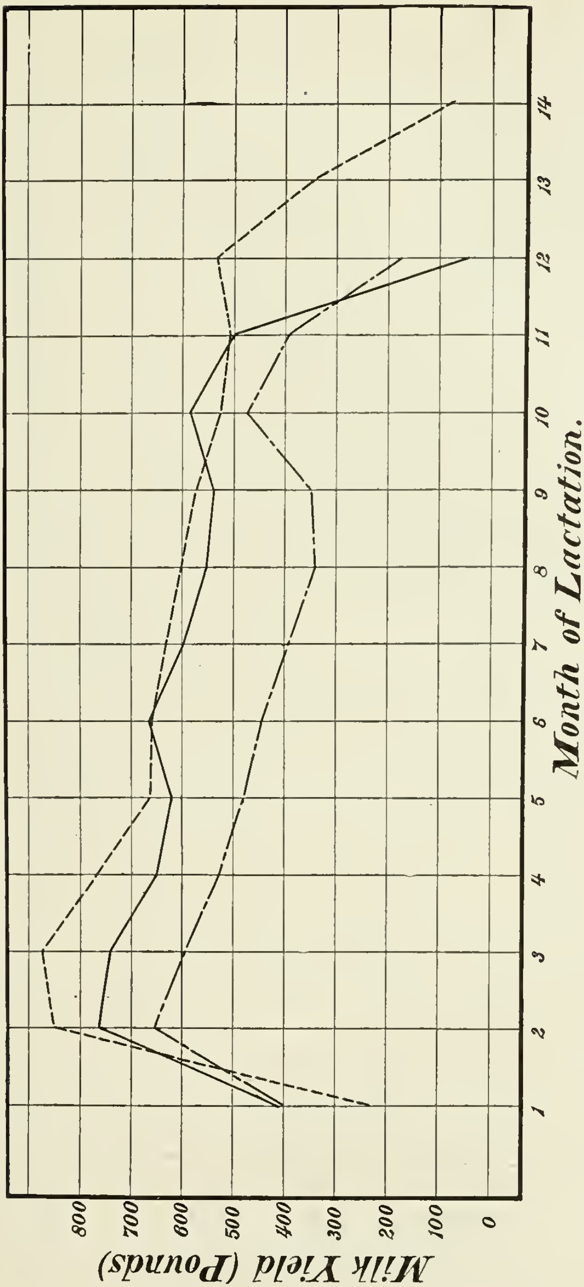

FIGURE 29. Shows the milk production of Crossbred No. 11, on a monthly basis. The significance of the three different lines is the same as that for Figure 28. The parents of this cow are the Jersey bull, Lakeland's Poet 102603 and the Holstein-Friesian cow Delva Johanna Dekol 146774.

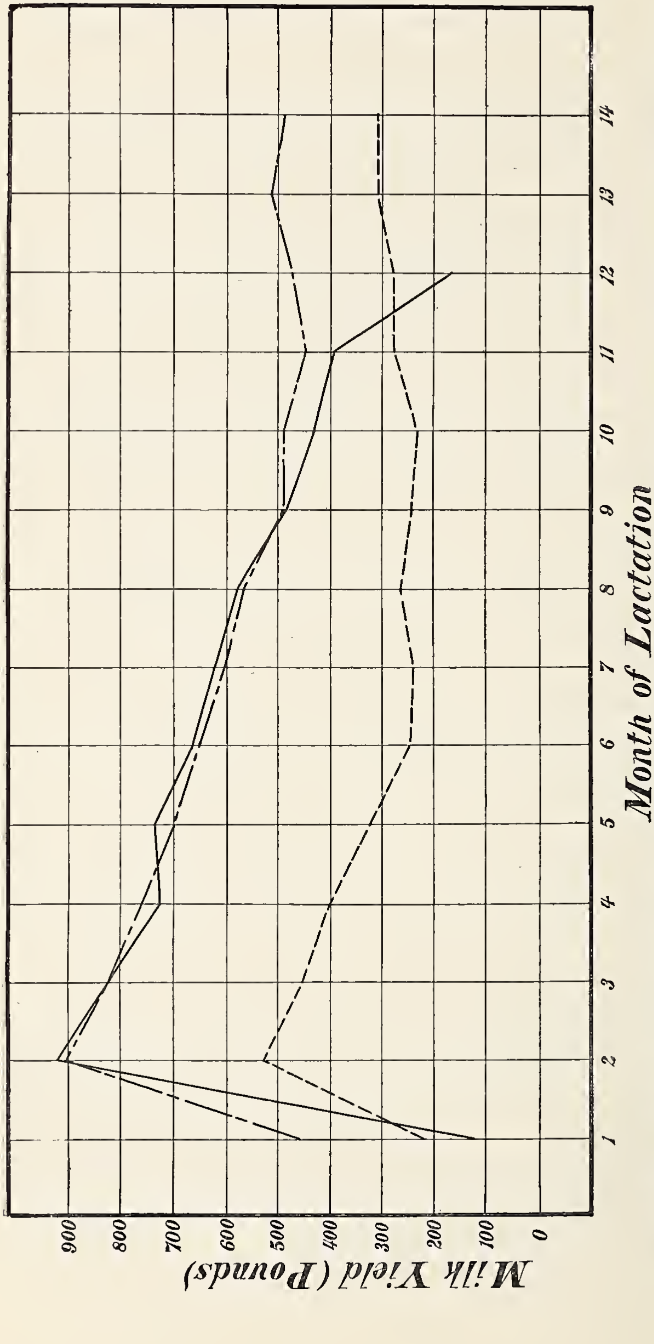

FIGURE 30. Curves showing the milk production of the Crossbred No. 12 in connection with that of her pure bred Guernsey dam, College Gem 40037, and her Holstein-Friesian sire, Taurus Creamelle Hengerveld 98482. The significance of the different kinds of lines is the same as that for those of figure 28.

The milk production of Crossbred No. 12 clearly follows that of her pure bred Holstein-Friesian parent as far as the ninth month of lactation. The dropping of her lactation from this point on does not represent a true statement of the cow's producing capacity for the dropping in the milk production at this time represents only an effort of the herdsman to dry the cow off for a succeeding lactation. It is entirely probable therefore, that this cow shows the high milking capacity of her high producing parent throughout the entire lactation.

The record for Crossbred No. 15 shown in figure 31 is based on the corrected records of two lactations. The record for her dam is based on that for four lactations. The sire's record is the average of four of his tested offspring. It is clear that Crossbred No. 15 is much higher in milk production than her pure bred Aberdeen Angus mother. It is not so clear although it is probably true that up to the sixth month of lactation Crossbred No. 15 is giving less milk than would be expected of her given that she was of her sire's breeding. From the sixth month on Crossbred No. 15 gives the milk yield expected of her sire's breeding.

It will be noted that the dam's yield stops in the eighth month of lactation as the latest date at which her milk flow could be maintained. The milk flow of Crossbred No. 15 on the other hand is maintained equally well with that of the Jersey sire. The tendency to a prolonged milk flow was maintained by the Crossbred cow in accordance with the milk flow expected of her sire.

The milk production of Crossbred No. 16 as shown by the solid curve in figure 32 is based on only one lactation record. This cow has been difficult to settle. She has in fact lost practically one whole lactation due to this cause. At the present time she is in milk for her second lactation. This lactation started, however, at 4 years old with a previous rest of one year and one month. If the milk production of this first month is any indication the milk production of this lactation will be much higher relatively than the milk production of her first lactation.

This Crossbred cow is the result of a mating of an Aberdeen Angus bull, Kayan 167617 on to a Jersey cow, College Ruth 4895 M. S. J. HB. The milk production of this Crossbred is clearly intermediate between the two breeds, favoring if any-

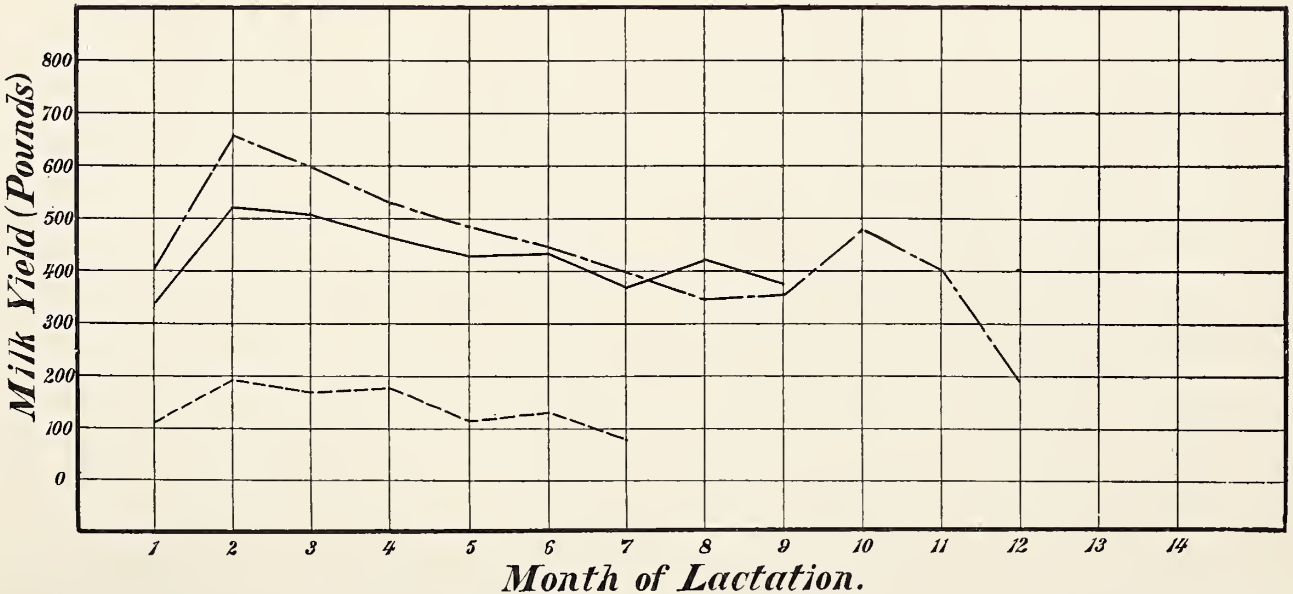

FIGURE 31. Curves showing the milk production of Crossbred No. 15. This cow is a cross between a Jersey bull, Lakeland's Poet 102603 and an Aberdeen Angus cow, Hearthbloom 147141. The significance of the different lines is the same as that of figure 28.

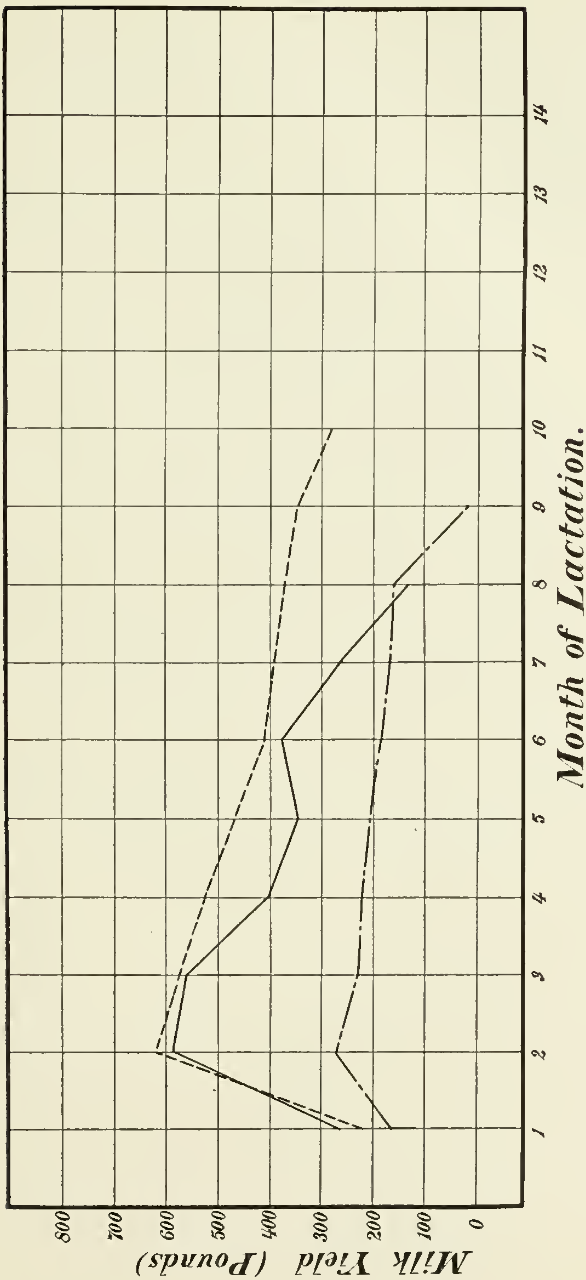

FIGURE 32. Curves showing the milk yield of Crossbred No. 16. This cow is a cross between an Aberdeen Angus bull, Kayan 167617, and a Jersey cow, College Ruth 4895 M.S.J. HB. The curves have the same significance as in the previous figures.

thing in the first part of the lactation the milk yield of the high breed. The rapid decline of the seventh and eighth months would make it seem that this cow inherited some of the tendency to a short lactation like that of her sire's breed.

The results herein presented may be summarized in two brief statements.

(1) When a mating is made between strains of high milk producing ability and of low milk producing ability, the milk production is likely to fall somewhere between the two parents but will most nearly be that of the high producing parent. One exception more apparent than real may be said to occur in Crossbred No. 1 milk yield. This case, however, probably follows this same law in that Pauline Posch herself may have a high milk producing inheritance from one side and a low milk producing inheritance from the other. If this is granted it is not strange that when mated to a lower milking breed, that this lower inheritance of Pauline Posch should meet the lower of the milk producing inheritance of the lower breed when bred to a calf of lower milk yielding capacity.

(2) The milk yield of the breeds seem to occupy the following relation: The low milk yield of the Aberdeen Angus is recessive to the higher milk yield of the Jersey. The Jersey milk yield is recessive to the higher milk yield of the Holstein-Friesian.

The application of these results to the pure breeding work seems too obvious to mention. Among other things these results show why a bull from the mating of two high producing strains may be very disappointing as a transmitter of milk production.